



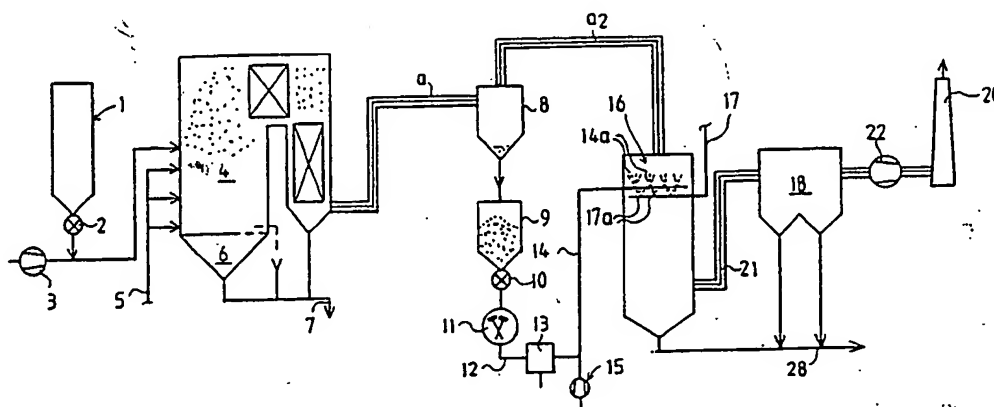
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(21) International Application Number: PCT/FI90/00037 (22) International Filing Date: 7 February 1990 (07.02.90) (30) Priority data: 890732 15 February 1989 (15.02.89) FI (71) Applicant (for all designated States except US): IMATRAN VOIMA OY [FI/FI]; PL 138, SF-00101 Helsinki (FI). (72) Inventor; and (75) Inventor/Applicant (for US only) : ASIKAINEN, Ari [FI/FI]; Paasipolku 8, SF-01700 Vantaa (FI). (74) Agent: FORSSÉN & SALOMAA OY; Uudenmaankatu 40 A, SF-00120 Helsinki (FI).		(81) Designated States: AT, AT (European patent), AU, BE (European patent), BG, BR, CA, CH, CH (European patent), DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FR (European patent), GB, GB (European patent), HU, IT (European patent), JP, KP, KR, LU, LU (European patent), MC, NL, NL (European patent), NO, RO, SE, SE (European patent), SU, US. Published <i>With international search report.</i>

(54) Title: PROCESS AND EQUIPMENT FOR CLEANING OF FLUE GASES



(57) Abstract

The invention concerns a process for cleaning of flue gases, wherein a solid material separated from a pre-separator (8) is transferred into an activation device (11) placed after the pre-separator (8), which crushes the pre-separated material particles to smaller particles, whereby the CaSO_4 crust placed around CaO is broken and the CaO is liberated for a hydration reaction. In the process the crushed dust-like material that contains CaO is transferred from the activation device (11) downstream into a reactor (16), which is placed after the flue-gas pre-separator (8) in the direction of flow of the flue gases. In the process the CaO particles are hydrated substantially in the reactor (16) by introducing the CaO particles through nozzles (14a) into a drop zone (A) in the reactor (16), into which zone the water is also introduced through nozzles (17a), whereby the CaO reacts immediately with the water, and the Ca(OH)_2 formed reacts further with the flue gas made to flow in the reactor (16) and binds SO_2 contained in the flue gas. The invention also concerns equipment for cleaning of flue gases.

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1 Process and equipment for cleaning of flue gases

5 The invention concerns a process and a device for cleaning of flue gases, in which said process an absorption agent is carried into the furnace of a boiler and said agent is reacted with the sulfur contained in the flue gases, the flue gases are carried further out of the furnace of the boiler along an exhaust duct to a pre-separator,
10 which separates any absorption agent unreacted with sulfur from the flue gas and carries said unreacted product into a separate processing unit, wherein the product is activated mechanically.

From the applicant's earlier published Finnish Patent Application
15 No. 76,931 a process is known wherein the solid material separated from the pre-separator is hydrated and brought into a form reactive with sulfur and transferred downstream into a reactor, which is placed after the flue-gas pre-separator in the direction of flow of the flue gases.

20

The object of the invention is an improvement of the above process and in particular of its hydration process. The object is a process and a device by whose means it has been possible to intensify the removal of sulfur out of the flue gases after the furnace of a
25 boiler to a considerable extent.

The object of the invention has been achieved by means of a solution wherein the CaO and CaSO_4 separated from the flue gases are processed by means of an activation device mechanically, e.g., by crushing,
30 whereby the CaSO_4 crust surrounding the CaO particles is broken and the CaO is liberated for the hydration reaction. Advantageously, after the activation device, an after-separator is used, wherein the reactive CaO is separated from the other material and from which said after-separator the CaO dust is passed into a reactor in which
35 the hydration proper takes place. The hydrated CaO reacts further with the flue gas introduced into the reactor and binds SO_2 contained in the flue gas efficiently.

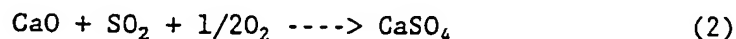
- 1 In the following, the entire cleaning process will be described step by step.

In the first step, finely ground limestone is blown into the furnace
5 of the boiler to a temperature of 900°C...1200°C, whereby the calcium carbonate is decomposed in accordance with the reaction equation (1):



10

Part of the calcium oxide formed hereby reacts further with sulfur dioxide (2):



15

Thereby calcium sulfate is formed. The proportion of the sulfur that reacts in the furnace may be 10...70 per cent of the overall quantity of sulfur. When an amount of reagent is used that is economically rational in relation to the sulfur contained in the
20 coal, the separation of sulfur taking place in the furnace is thereby about 30...50 % of the total quantity of SO₂. In order that levels lower than the emission limits imposed could be reached, it is mostly necessary to continue the binding of sulfur in a processing taking place after the boiler.

25

In the second step of the process, the unreacted CaO and the reaction products are carried along with the flue gases out of the boiler and end up in a pre-separator. As the pre-separator it is possible to use all dry dust separation devices.

30

When the particle size of the limestone blown into the furnace has been chosen appropriately in relation to the fly ash, only the fraction that contains mainly CaO ends up in further processing. However, particles of CaO covered with a layer of CaSO₄ also always
35 end up in the further processing, in which case the CaO is activated in accordance with the invention in an activation device, preferably in a press, by crushing the CaSO₄ crust that surrounds the CaO and by

1 liberating the CaO for the hydration reaction.

In the further treatment the separated and ground fraction is hydrated in a reactor in accordance with the following equation.

5



The hydration is indispensable in order that the SO₂ still remaining in the flue gases could be reacted and removed from the gas in
10 accordance with the reaction equation (2).

After the reactor the fly ash and the reaction products are separated from the flue gases. The separator may be, e.g., an electric filter or a hose filter. When a hose filter is used,
15 reaction of binding of sulfur also takes place in the layer of dust formed on the face of the hose.

The process in accordance with the invention is mainly characterized in that the solid material separated from the pre-separator is
20 transferred into an activation device after the pre-separator, which crushes the pre-separated material particles to smaller particles, whereby the CaSO₄ crust placed around CaO is broken and the CaO is liberated for the hydration reaction, and in which said process the crushed dust-like material that contains CaO is transferred from the
25 activation device downstream into a reactor, which is placed after the flue-gas pre-separator in the direction of flow of the flue gases, and that in the process the CaO particles are hydrated substantially in the reactor by introducing the CaO particles through nozzles into a drop zone in the reactor, into which zone the
30 water is also introduced through nozzles, whereby the CaO and the water drops can be made to meet in a controlled way, and CaO reacts immediately with water, and the Ca(OH)₂ formed reacts further with the flue gas made to flow in the reactor and binds SO₂ contained in the flue gas.

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The equipment in accordance with the invention is mainly characterized in that, after the pre-separator, the equipment

1 comprises an activation device, which crushes the pre-separated
material particles to smaller particles, whereby the CaSO_4 crust
placed around the CaO is broken and the CaO is liberated for a
hydration reaction, the equipment comprising a duct through which
5 the CaO -containing particles are transferred to hydration in a
reactor, which is placed after the flue-gas pre-separator in the
direction of flow of the flue gases, and said equipment comprising
nozzles through which the CaO particles are introduced into the
reactor, whereas the water spray nozzles are placed substantially at
10 the proximity of said nozzles.

The invention will be described in the following with reference to
some preferred embodiments of the invention illustrated in the
figures in the drawing, the invention being, however, not supposed
15 to be confined to said embodiments alone.

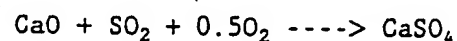
Figure 1A shows a press used as an activation device.

Figure 1B is a schematical illustration of the liberation of CaO in
20 the pressing process.

Figures 2 and 3 are schematical illustrations of the process and of
the equipment.

25 In the process for cleaning of flue gases illustrated in Figures 1A
to 3, limestone powder is fed into the furnace so that it is first
calcinated to calcium oxide (CaO) and then reacts with the sulfur
com-pounds contained in the flue gases and forms calcium sulfate
(CaSO_4).

30



The proportion of the CaO that participates in the reaction is
5...30 per cent, as a rule 15 per cent. The reason for the low
35 utilization of calcium is the CaSO_4 crust formed in the reaction,
which retards the process of the reaction after a certain layer
thickness so that, during the available 0.5...5 s, usually less than

1 2 s, the reaction does not have time to take place. An excessively high temperature, usually $< 1150^{\circ}$, causes sintering on the faces of the limestone particles, which deteriorates the reactivity.

5 The reaction products and the fly ash are carried along with the flue gases into the sulfur-removing unit after the boiler, wherein the unreacted CaO is first pre-separated.

By means of the process in accordance with the invention, the
10 calcium-containing CaO particle is reactivated by breaking the CaSO_4 crust that surrounds it. This takes place after the pre-separation of the CaO in an activation device, advantageously in a press. The product crushed fine in the activation device is fed into the drop zone in the flue-gas moistening reactor, whereby CaO is hydrated to
15 $\text{Ca}(\text{OH})_2$, which binds SO_2 efficiently and forms calcium sulfite CaSO_3 . The feeding of the fine-crushed product takes place, e.g., by means of carrier air so that powdery product is fed through nozzles into the drop zone in the flue-gas moistening reactor. Thus, CaO is hydrated to $\text{Ca}(\text{OH})_2$ substantially in the flue-gas moistening reactor.

20 Only the particles with the highest contents of calcium oxide CaO are passed to the hydration process, whereas, e.g., the fly ash is separated in an after-separator after the activation device.

25 Thus, the following reactions take place in the drop zone in the flue-gas moistening reactor: CaO is hydrated to $\text{Ca}(\text{OH})_2$, and $\text{Ca}(\text{OH})_2$ reacts with the sulfur oxide SO_2 contained in the flue gas and forms calcium sulfite CaSO_3 .

30 Besides producing the hydration process, the flue gases are also cooled by means of the water sprayed into the drop zone in the flue-gas moistening reactor.

Fig. 1A illustrates an activation device 11 in accordance with the
35 invention, which is preferably a press. From the pre-separator the pre-separated CaO-containing material flow J is passed into the press 11, where it is carried between press disks E_1 and E_2 while the

1 revolving disks E_1, E_2 pull material into the space between the disks
2 E_1, E_2 , the material being subjected to intensive compression.

Fig. 1B illustrates a CaO particle, which is surrounded by a CaSO_4
5 crust, the crust retarding the hydration of CaO in the hydration
reaction substantially. According to the invention, this CaSO_4 crust
is broken by pressing the CaO- CaSO_4 particle between the mechanical
press disks E_1, E_2 . At the CaO- CaSO_4 interface fracture lines F_1, F_2, F_3
are formed, and CaSO_4 is detached along the interface from the face
10 of the CaO component, whereby CaO is liberated for the hydration
reaction.

In Fig. 2, the silo for the absorption agent, preferably limestone,
is denoted with the reference numeral 1. In the bottom part of the
15 silo there is a dosage device 2 for the absorption agent. The
transfer air blower 3 blows the carrier air, in which the absorption
agent is mixed, into the furnace of the boiler 4. The combustion air
and the coal are introduced along the ducts 5. In the preferred
embodiment the boiler is a dust-burning boiler. But such an embodi-
20 ment is also possible wherein the boiler is a so-called grate-
furnace boiler or a combined grate-furnace/dust-burning boiler, in
which case the grate is denoted with the reference numeral 6 (as in
the figure). The slag is removed from the boiler along the duct 7.
The flue gases are passed out of the boiler construction along the
25 flue-gas duct a into the flue-gas pre-separator 8. In the preferred
embodiment the pre-separator 8 consists of a cyclone. The sorted
particles are separated into an intermediate silo 9. The closing
device 10, which is advantageously a so-called closing feeder,
distributes the fraction, which has entered from the pre-separator 8
30 into the intermediate silo 9, into the activation device 11,
preferably a press. From the reactor 16 the flue gas is passed along
the duct 21 into the dust separation device 18. The dust separation
device may comprise an electric filter or a hose filter device for
separation of the dust. The flue-gas blower 19 sucks the flue gas
35 out of the dust separation device 18 and blows it into the chimney
20 and from there further into the open air. From the units 16 and
18 the separated flue-gas impurities, e.g. CaSO_4 , are removed along

1 the exhaust line 28.

In the activation device 11 the sintered pre-separated CaO and the CaSO₄ particles are processed mechanically, the CaO particle being
5 reactivated by breaking the CaSO₄ crust surrounding the CaO, so that the CaO is liberated for hydration. From the activation device 11 the activated particle is carried along the duct 12 into the after-separator 13 and along the duct 14 into the reactor 16. Carrier air or carrier gas is supplied into the duct 14 by means of a blower
10 arrangement 15. The material can also be passed from the activation device 11 directly into the reactor 16, in which case no after-separator 13 is used. The dust-like activated CaO-containing material is sprayed through the nozzle 14a into the drop zone A in the reactor 16. The water is also atomized into the drop zone A in
15 the reactor 16, said water producing hydration of CaO into Ca(OH)₂. A second purpose of the supply of water is cooling of the flue gases. The hydrated CaO reacts, in the form of Ca(OH)₂, efficiently with the SO₂ contained in the flue gases and forms calcium sulfite CaSO₃. The water is passed along the duct 17 and atomized as drops
20 through the end nozzles 17a of the duct 17 into the reactor 16. The end nozzles 17a are placed right next to the dust nozzles 14a, so that direct contact and reaction between the constituents participating in the hydration reaction are ensured.

25 The reactive CaO dust separated from the flue-gas flow is passed efficiently into the area of the water mist A in the reactor 16, so that a good water/solids contact is ensured. The flue gas is made to flow in the reactor 16 so that the flue gas and the Ca(OH)₂ particles formed on hydration meet one another as efficiently as possible.
30 Thereby good contact of Ca(OH)₂ particles with the SO₂ contained in the flue gas is ensured. The directions of introduction of the CaO-containing dust and of water out of their nozzles 14a, 17b are favourably perpendicular to the direction of flow (S) of the flue gas.

35

The supply of water and dust can be carried out in a concentrated way to the centre of the reactor 16 so that the walls of the reactor

1 remain dry.

Water is fed through the nozzles 17a so that the heat contained in the flue gases has time to evaporate all the water and that wet
5 solids suspension or waste water is not formed at any stage.

Fig. 3 is a more detailed illustration of the process and equipment in accordance with the invention. When the CaO-CaSO_4 mixture is processed mechanically by means of the activation device 11, e.g. a
10 press, mill, grinder, crusher, the CaSO_4 crust surrounding the CaO is broken so that CaO is liberated for hydration. In the way shown in Fig. 2, the mechanically processed CaO and CaSO_4 are passed further along the duct 12 into the after-separator 13. In the after-separator 13 classification takes place, by means of which it is
15 possible to separate fly ash or CaSO_4 from the active CaO dust flow, and thereby it is possible to reduce the dust load of the reactor 16 and the dust load of the dust separation device after the reactor 16. As is shown in Fig. 3, the processed activated dust-like CaO material is fed through the nozzle 14a in the duct 14 into the flue-
20 gas flow S in the reactor 16, and said feeding takes place into the drop zone A in the flue-gas reactor, at the same time with the water mist D fed into the drop zone A out of the nozzles 17a. The water mist D is introduced out of the nozzles 17a in the duct 17. The nozzles 17a are placed in the drop zone A of the reactor 16 at the
25 proximity of the dust nozzles. The drop zone A means the area inside the reactor 16 in which the atomized water H_2O has not yet been vaporized by the effect of the thermal energy transferred from the flue gas S.

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1 CLAIMS:

1. Process for cleaning of flue gases, wherein an absorption agent is carried into the furnace of a boiler (4) and said agent is
5 reacted with the sulfur contained in the flue gases, and wherein the flue gases are carried further out of the furnace of the boiler along an exhaust duct (a) to a pre-separator (8), which separates any absorption agent unreacted with sulfur from the flue gas as well as part of the particles of absorption agent that have already
10 reacted with the sulfur contained in the flue gas, c h a r a c - t e r i z e d in that the solid material separated from the pre-separator (8) is transferred into an activation device (11) placed after the pre-separator (8), which crushes the pre-separated material particles to smaller particles, whereby the CaSO_4 crust
15 placed around CaO is broken and the CaO is liberated for a hydration reaction, and in which said process the crushed dust-like material that contains CaO is transferred from the activation device (11) downstream into a reactor (16), which is placed after the flue-gas pre-separator (8) in the direction of flow of the flue gases, and
20 that in the process the CaO particles are hydrated substantially in the reactor (16) by introducing the CaO particles through nozzles (14a) into a drop zone (A) in the reactor (16), into which zone the water is also introduced through nozzles (17a), whereby the CaO and the water drops can be made to meet in a controlled way, and CaO
25 reacts immediately with the water, and the Ca(OH)_2 formed reacts further with the flue gas made to flow in the reactor (16) and binds SO_2 contained in the flue gas.

2. Process as claimed in claim 1, c h a r a c t e r i z e d in
30 that, before the CaO-containing material crushed in the activation device (11) is transferred into the reactor (16), the constituents with the highest contents of CaO are separated in an after-separator (13) placed after the activation device (11) and transferred into the reactor (16).

35

3. Process as claimed in claim 1 or 2, c h a r a c t e r i z e d in that the dust-like CaO-containing material is brought into the

1 reactor (16) along with carrier air or carrier gas.

4. Process as claimed in any of the preceding claims, c h a r a c -
t e r i z e d in that the hydration is started before the reactor
5 (16) by feeding steam or water into the CaO-containing material flow
after the activation device (11).

5. Process as claimed in any of the preceding claims, c h a r a c -
t e r i z e d in that the CaO-containing dust-like material is fed
10 into a drop zone (A) in the reactor (16) into the central area in
the reactor (16), and it is made to flow out of the nozzles in such
a way towards the flue gas (S) that the directions of flow and the
velocities of the flue gas and the dust are optimal in view of
obtaining a good contact between the reactive substances.

15 6. Process as claimed in any of the preceding claims, c h a r a c -
t e r i z e d in that the water is sprayed out of nozzles (17a)
which are placed right at the side of the dust nozzles (14a),
whereby an optimal contact between the reactive constituents is
20 permitted, and that the water and the CaO-containing dust are
sprayed in such a way that their directions of flow are
substantially contrary to the direction of flow (S) of the flue gas.

7. Process as claimed in any of the preceding claims, c h a r a c -
25 t e r i z e d in that in the method a mechanical activation device,
preferably a press, is used as the activation device (11).

8. Equipment for cleaning of flue gases, comprising a flue-gas duct
(a) passing out of the furnace of the boiler (4) and therein a
30 branch point to a pre-separator (8), which separates the absorption
agent that has been fed into the furnace of the boiler (4) but has
not reacted with sulfur from the flue gas as well as, also, part of
the particles of absorption agent that have already reacted with the
sulfur contained in the flue gas, c h a r a c t e r i z e d in
35 that, after the pre-separator (8), the equipment comprises an
activation device (11), which crushes the pre-separated material
particles to smaller particles, whereby the CaSO₄ crust placed around

11

1 the CaO is broken and the CaO is liberated for a hydration reaction,
the equipment comprising a duct (14) through which the CaO-
containing particles are transferred to hydration in a reactor (16),
which is placed after the flue-gas pre-separator (8) in the
5 direction of flow of the flue gases, and said equipment comprising
nozzles (14a) through which the CaO particles are introduced into
the reactor (16), whereas the water spray nozzles (17a) are placed
substantially at the proximity of said nozzles (14a).

10 9. Equipment as claimed in claim 8, c h a r a c t e r i z e d in
that the equipment comprises an after-separator (13) between the
activation device (11) and the reactor (16), in which case only the
particles with the highest contents of CaO are transferred into the
reactor (16).

15 10. Equipment as claimed in any of the preceding claims 8 or 9,
c h a r a c t e r i z e d in that the equipment comprises a blower
(15) or equivalent, by whose means a flow of carrier air is produced
into the material fraction transferred along the duct (14).

20 11. Equipment as claimed in any of the preceding claims 8, 9 or 10,
c h a r a c t e r i z e d in that the activation device (11)
consists of a press.

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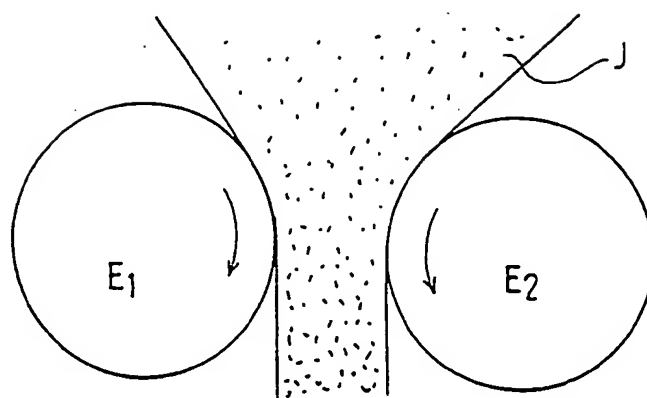


FIG. 1A

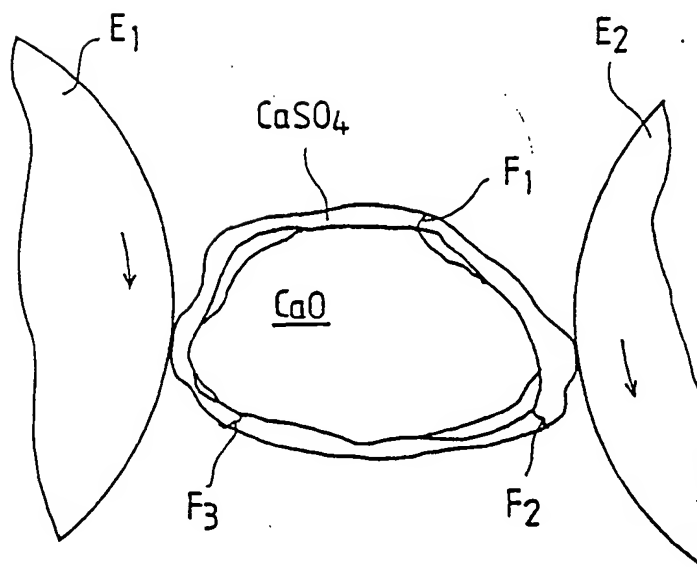


FIG. 1B

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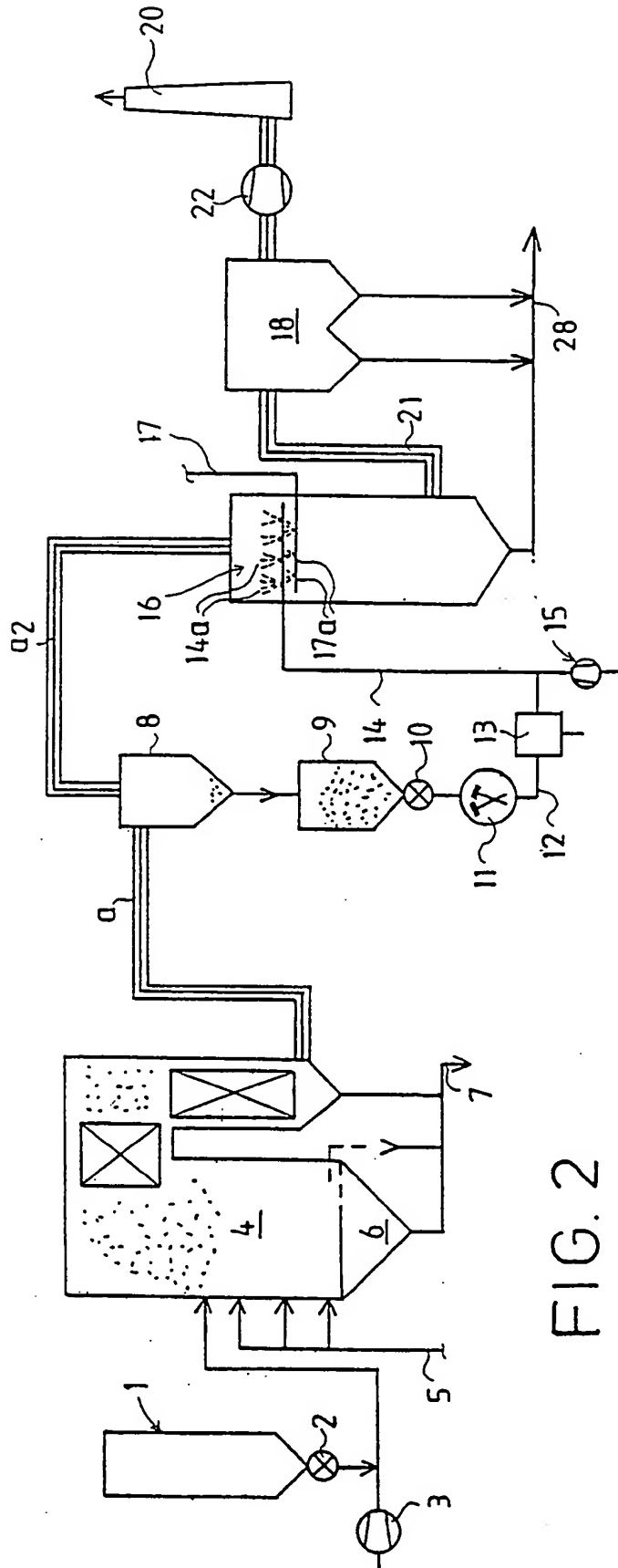


FIG. 2

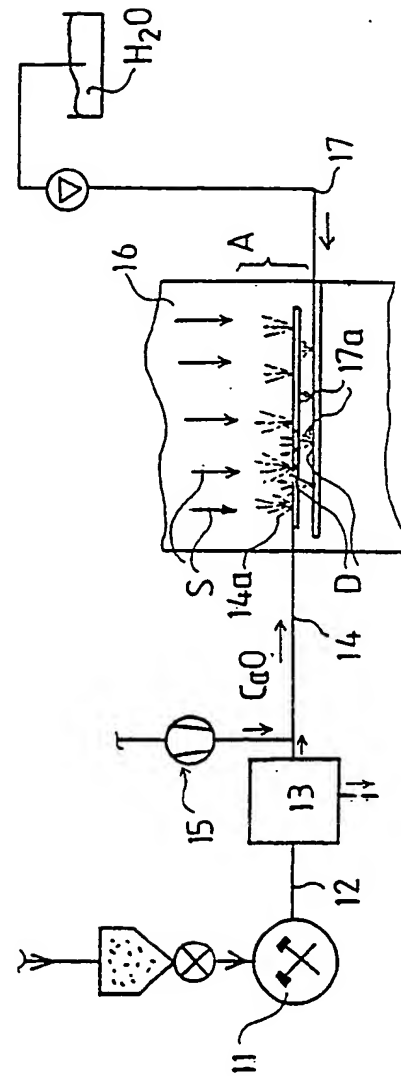





FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/FI 90/00037

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶ According to International Patent Classification (IPC) or to both National Classification and IPC IPC5: B 01 D 53/34																	
II. FIELDS SEARCHED <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Minimum Documentation Searched⁷</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%; border-bottom: 1px solid black;">Classification System</td> <td style="border-bottom: 1px solid black;">Classification Symbols</td> </tr> <tr> <td style="height: 40px; vertical-align: bottom;">IPC5</td> <td style="vertical-align: bottom;">B 01 D; C 01 F; C 04 B; F 23 J</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched⁸</div> <p>SE,DK,FI,NO classes as above</p>			Classification System	Classification Symbols	IPC5	B 01 D; C 01 F; C 04 B; F 23 J											
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III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹ <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Category *</th> <th style="width: 60%;">Citation of Document,¹¹ with indication, where appropriate, of the relevant passages¹²</th> <th style="width: 30%;">Relevant to Claim No.¹³</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td>EP, A2, 0072993 (GLESINGER, INGO) 2 March 1983, see the whole document --</td> <td style="text-align: center; vertical-align: top;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td>DE, A1, 3428502 (STAUDINGER, GERNOT) 7 March 1985, see the whole document --</td> <td style="text-align: center; vertical-align: top;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">Y</td> <td>WO, A1, 88/04196 (IMATRAN VOIMA OY) 16 June 1988, see the whole document --</td> <td style="text-align: center; vertical-align: top;">1,8</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">Y</td> <td>GB, A, 2169887 (OY TAMPELLA AB) 23 July 1986, see the whole document -- -----</td> <td style="text-align: center; vertical-align: top;">1,8</td> </tr> </tbody> </table>			Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	A	EP, A2, 0072993 (GLESINGER, INGO) 2 March 1983, see the whole document --	1	A	DE, A1, 3428502 (STAUDINGER, GERNOT) 7 March 1985, see the whole document --	1	Y	WO, A1, 88/04196 (IMATRAN VOIMA OY) 16 June 1988, see the whole document --	1,8	Y	GB, A, 2169887 (OY TAMPELLA AB) 23 July 1986, see the whole document -- -----	1,8
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Y	WO, A1, 88/04196 (IMATRAN VOIMA OY) 16 June 1988, see the whole document --	1,8															
Y	GB, A, 2169887 (OY TAMPELLA AB) 23 July 1986, see the whole document -- -----	1,8															
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>* Special categories of cited documents: ¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&" document member of the same patent family</p> </div> </div>																	
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-bottom: 1px solid black;">Date of the Actual Completion of the International Search</td> <td style="width: 50%; border-bottom: 1px solid black;">Date of Mailing of this International Search Report</td> </tr> <tr> <td style="text-align: center;">3rd May 1990</td> <td style="text-align: center;">1990 -05- 21</td> </tr> <tr> <td style="border-bottom: 1px solid black;">International Searching Authority</td> <td style="border-bottom: 1px solid black;">Signature of Authorized Officer</td> </tr> <tr> <td style="text-align: center;">SWEDISH PATENT OFFICE</td> <td style="text-align: center;">  Britt-Marie Lundell </td> </tr> </table>			Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	3rd May 1990	1990 -05- 21	International Searching Authority	Signature of Authorized Officer	SWEDISH PATENT OFFICE	 Britt-Marie Lundell							
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SWEDISH PATENT OFFICE	 Britt-Marie Lundell																

ANNEX TO THE INTERNATIONAL SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 90-03-30. The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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